

Statistical Process Control (SPC)

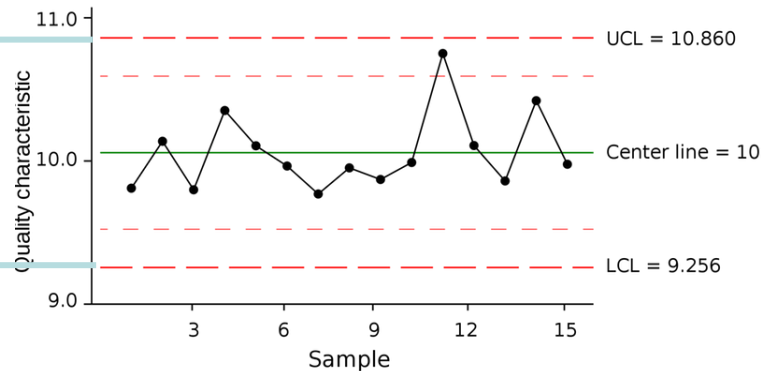
Problem

How to ensure process quality?

Difficulty

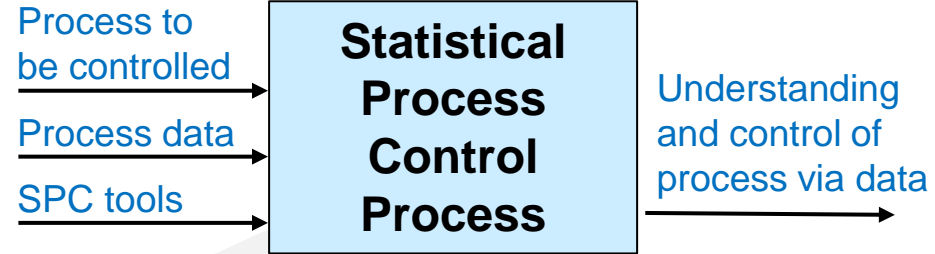
Work with an SME

- **Statistical Process Control (SPC)** is the application of statistical methods to the monitoring & control of a process to ensure that it produces conforming products
- **SPC** involves collecting data, controlling a process through data charting and analysis, and understanding process capability.



Upper/Lower Control limits
(not customer specification limits)

<https://neatec.org/event/introduction-to-statistical-process-control-spc-for-college-faculty/>



1. Define the **objectives** for a specific process
2. **Plan** data collection points
3. **Plan** data analysis method
4. **Understand** & improve measurement system (see 6in6 on Gage R&R)
5. **Collect** & **review** data
6. Calculate control limits
7. **Monitor** & correct process based on data collected (see 6in6 on Control Charts)
8. Determine **process capability** (Cp and Cpk, see 6in6 on Process Capability)
9. Iterate process

Statistical Process Control (SPC) – Examples

There are many ways to

- Calculate control limits
- Monitor & correct process via collected data

The “Western Electric rules,” only useful for hand analysis, are below.

Western Electric rules

- **Step 0** – find the process’ sample mean (m) and standard deviation (s)
- **Step 1** – create symmetric control limits, using $\pm 3s$
- **Step 2** – define 3 “zones”
 - Zone C \rightarrow region within $1s$ of m
 - Zone B \rightarrow region between $1s$ and $2s$ of m
 - Zone A \rightarrow region between $2s$ and $3s$ of m
- **Step 3** – plot new data points as they arrive and look for certain patterns that may indicate a process is not in control. Some of these patterns are shown below.

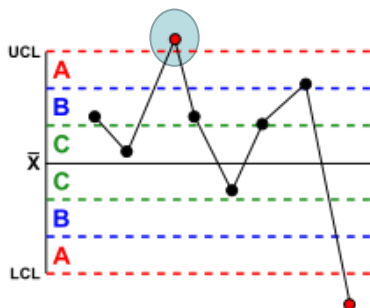
For discrete defect data, the different control charts are p, np, u, and c.

		Interest	
		Defects	Defectives
Sample size	constant	c-chart	np-chart
	variable	u-chart	p-chart

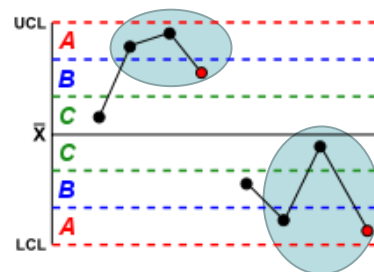
Many other rules have been described:

- There are **8 “Nelson rules”**
https://en.wikipedia.org/wiki/Nelson_rules
- There are **6 “Westgard rules”**
https://en.wikipedia.org/wiki/Westgard_rules
- There are **6 “Western Electric rules”** for data analysis using a range (R) chart – different from an (m,s) chart.
https://en.wikipedia.org/wiki/Western_Electric_rules

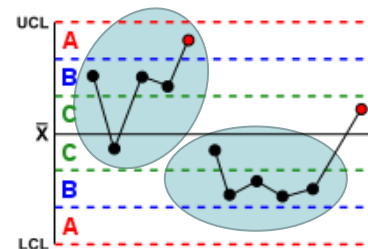
Rule 1: Any point beyond Zone A



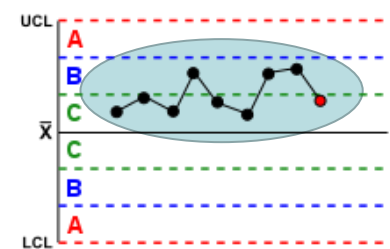
Rule 2: two out of three consecutive points fall Zone A or beyond



Rule 3: Four out of five consecutive points fall Zone B or beyond



Rule 4: Nine consecutive points on the same side of center line (mean)



https://en.wikipedia.org/wiki/Western_Electric_rules

Statistical Process Control (SPC) – Notes

Slide 1

1. The use of software for SPC is highly recommended; many popular software packages have this capability.
2. SPC software should be used for monitoring a system in real-time.

Slide 2

1. For many of the patterns for the Western Electric rules, a physical rationale can be given why the system is not in control.
2. Rule #4 may indicate a systematic measurement system problem (i.e., bias).